JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 15 APRIL 4, 1925 No. 7

RADIOTELEGRAPHY.—*Some transpacific radio field intensity measurements.* L. W. AUSTIN, Laboratory for Special Radio Transmission Research, Bureau of Standards.

Radio field intensity measurements for frequencies varying roughly between 1,000 and 15 kc. (300 m. and 20,000 m.), and for distances up to 6,500 km., by daylight and over salt water, have been made by a number of independent observers and the results, with some exceptions,[1] are in fair agreement. For frequencies from 1,000 at least down to 60 kc. (300 m. to 5,000 m.), the observed results agree within the limits of experimental certainty with the values calculated from the Austin-Cohen formula, up to the greatest distances attempted; (5,500 km.).[2] The lower frequencies ordinarily used for long-distance communication, say from 15 to 30 kc. (10,000 to 20,000 m.), give observed values somewhat larger than those calculated. At a distance of 6,000 km. this ratio of observed to calculated values amounts, on an average, to about two to one.[3] Only a limited number of observations have been taken at distances much greater than this, and these have generally indicated a considerable increase in the observed to calculated ratio.[4]

In order to get more reliable data at these greater distances, observations were taken in August and September, 1924, at San Diego, California, on the signals from Cavite, P. I., and from Malabar, Java.

[1] VALLAURI, G., Proc. Inst. Radio Eng. **8**: 286. 1920. GUIERRE, M., Radio Review **2**: 618. 1921. BÄUMLER, M., Elek. Nach. Tech. **1**: 50. 1924.

[2] AUSTIN, L. W., Bur. Stand. Sci. Papers no. 159. 1911; no. 286. 1914. BOWN, R., ENGLUND, C. R., and FRIIS, H. T., Proc. Inst. Radio Eng. **11**: 115. 1923.

[3] PICKARD, G. W., Proc. Inst. Radio Eng. **10**: 161. 1920. ECKERSLEY, J. L., Journ. Amer. Inst. Elect. Eng. **59**: 677. 1921. AUSTIN, L. W., Proc. Inst. Radio Eng. **11**: 459. 1923; **12**: 389. 1924.

[4] GUIERRE, M., Radio Review **2**: 618. 1921.

The distance from Cavite to San Diego is 11,800 km., with a difference in time of eight hours. This gives about two hours for observations in September without approaching the time of sunrise or sunset too closely. The distance from Malabar is 14,700 km., with a time difference of nine hours. These are about the greatest distances that can be attained for all daylight and approximately all water signal path with the present high-power stations of the world, except perhaps between Japan and Chile. This last would, however, give about ten hours difference in time and bring the sending and receiving stations rather close to their respective sunrise and sunset times.

The receiving measurements were made in the U. S. Naval receiving station, Point Loma, San Diego, under receiving conditions which, while not ideal, are believed to have given errors not greater than

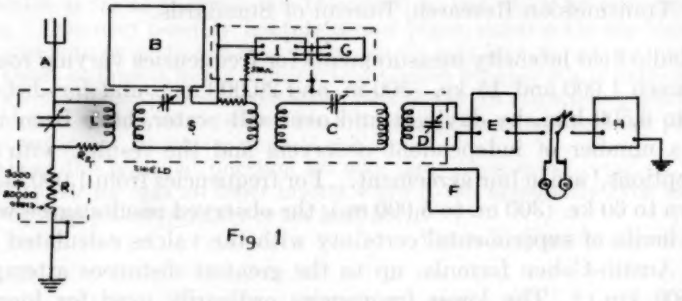


Fig. 1

twenty per cent. On account of the weakness of the signals, in comparison with the atmospheric disturbances, and to keep out strong interference from eastern stations, it was generally found necessary to make the measurements on Cavite and Malabar with unidirectional reception, using the general type of circuit described in the work on the direction of atmospheric disturbances in 1920.[5]

The arrangement of circuits is shown diagrammatically in Fig. 1. Here A is a single-wire antenna approximately 30 m. long and 20 m. high, B a square coil antenna of 48 turns and 2.44 m. on a side. This was mounted so as to be capable of rotation, with its lower side about 3 m. from the ground. C is an intermediate circuit to reduce interference, D is the detector circuit, and E represents three stages of radio-frequency transformer coupled amplification, adjusted to prevent regeneration. F is a heterodyne generator for producing the local

[5] AUSTIN, L. W., Journ. Franklin Inst. 619. 1921.

oscillations for beat reception. H is a telephone comparator[6] consisting of a General Radio tuning fork oscillator which generated a thousand cycle current which was measured on a thermogalvanometer and then passed through a voltage divider and resistances so that a known 1000-cycle EMF could be impressed on the telephones. In making the measurements, the heterodyne was adjusted so as to give a beat frequency with the signal equal to the frequency of the telephone comparator. The telephones could then be switched rapidly from the receiver to the telephone comparator, and the voltage divider adjusted until the telephone note was of the same intensity in each. The couplings between B, C, and D were all loose, and remained fixed during the whole course of the experiments. The heterodyne was coupled to the detector so as to give the loudest signal, and the coupling was separately adjusted for the different wave lengths received. The inductance L was connected to the antenna through a reversing switch so that the elevated antenna coil combination could be made to receive from either direction on the plane of the coil, while reception from the opposite direction was practically zero.

The receiving set was calibrated by introducing a known EMF in the coil antenna from the radio-frequency generator G. This consisted of the tuned plate electron tube generator proper, the output current of which, after being measured with a thermoelement and galvanometer, passed through an attenuation box (artificial line) I, kindly loaned by the Western Electric Company. From this it passed to a 1-ohm resistance S inserted in the loop. Ordinarily the current from G was adjusted to 1.6 milliamperes, which was reduced in the attenuation box I to 1/500 of its value, thus giving 3.2 microamperes in the resistance S. To prevent capacity coupling, the coil antenna was grounded at one terminal of S. The generator with its dry cell batteries and the attenuation box were enclosed in grounded copper boxes, as was the whole receiving set with the exception of the coil antenna.

The calibrating generator was furnished with a fixed condenser giving a frequency of 23.06 kc. (13, 000 m.). It had been intended to replace this in San Diego by a variable condenser so that calibrations could be made at all the frequencies of the stations being measured. Unfortunately no variable condenser was found available which was

[6] AUSTIN and JUDSON, Proc. Inst. Radio Eng. 12: 521. 1924.

small enough to be used in the copper box, so that it was necessary to do the calibrating at the single wave length and make corrections for the effect of change of frequency. As the calibration was made on the coil antenna with the elevated antenna disconnected, a correction for the presence of the elevated antenna in the reception of the signals was also necessary. This correction was determined by measurements made on the stronger stations with and without the elevated antenna. Reversal experiments with the coil antenna showed that the effect of its capacity to earth was negligible.

TABLE 1.—TRANSMITTING STATION DATA

	PEARL HARBOR (NPM)	TUCKERTON (WGG)	CAVITE (NPO)	MALABAR (PKX)
Frequency, kc	24.80	18.86	19.34	18.98
Wave length, m	12,090	15,900	15,500	15,800
Antenna current, Amp.	170	470	180	500
Radiation height, m	120	67.5	120	320
Distance, km	4,200	3,800	11,800	14,700

TABLE 2.—TELEPHONE COMPARATOR FACTOR (A) FOR VARIOUS FREQUENCIES

f, kc	λ, m.	A
24.80	12,090	0.402
19.34	15,500	0.504
18.98	13,800	0.524
18.86	15,900	0.545

Comparator reading × A = Electric field intensity in microvolts per meter.

Table 1 gives the data for calculation of the field intensities of the sending stations. The Malabar antenna[7] is suspended by steel cables in a mountain ravine about 1.5 km. wide at the top and with an average depth of about 550 m. According to information kindly furnished by Mr. Schotel of the Dutch Colonial Office, the antenna current is approximately 500 amperes at the frequency measured in San Diego. Estimates of the radiation height, from measurements made at moderate distances, vary between 320[8] and 480 m. These varying results are probably due to the mountainous character of the surrounding country. In the calculations the lower value, 320 m.,

[7] DEGROOT, C. J., Proc. Inst. Radio Eng. **12**: 693. 1924.

[8] Other engineers give even lower values.

TABLE 3.—COMPARISONS OF CAVITE (NPO) AND MALABAR (PKX) WITH TUCKERTON (WGG) AND PEARL HARBOR (NPM)

1924	TELEPHONE COMPARATOR READINGS				TELEPHONE COMPARATOR RATIOS				DISTURBANCES μV/m
	NPM	WGG	NPN	PKX	NPM/NPO	WGG/NPO	NPM/PKX	WGG/PKX	
August 28	85	—	7.5	—	11.3	—	—	—	14
August 30	110	—	6.5	15.0	16.9	—	7.4	—	23
September 1	55	—	3.5	4.0	15.7	—	13.7	—	—
September 2	—	45	—	5.0	—	—	—	9.0	12
September 3	—	40	—	3.0	—	—	—	13.3	—
September 4	—	100	—	17.0	—	—	—	5.9	38
September 5	—	100	3.0	—	—	33.4	—	—	—
September 6	100	100	6.3	—	15.8	15.8	—	—	—
September 8	50	80	4.3	—	11.6	18.6	—	—	50
September 9	55	80	4.3	7.7	12.8	18.6	7.1	10.4	25
September 10	45	80	5.0	6.0	9.0	16.0	7.5	13.3	50
September 11	50	78	4.3	—	11.6	18.1	—	—	—
September 12	40	70	3.0	10.0	13.3	23.4	4.0	7.0	5
September 13	50	80	6.3	—	7.9	12.7	—	—	20
September 15	48	80	—	17.0	—	—	2.8	4.7	25
Average					12.59	19.60	7.05	9.08	

TABLE 4.—DIRECT MEASUREMENTS USING THE CALIBRATING GENERATORS

1924	PEARL HARBOR (NPM)		CAVITE (NPO)		TUCKERTON (WGG)		MALABAR (PKX)		ATMOSPHERIC DISTURBANCES μV/m
	Telephone Comparator	E μV/m	Telephone Comparator	E μV/m	Telephone Comparator	E μV/m	Telephone Comparator	E μV/m	
September 17	40	16.1	4.0	2.0	—	—	7.1	3.7	14
			5.0	2.5					
			4.0	2.0					
September 18	45	18.1	6.0	3.0	90	49.0	4.8	2.5	
	60	24.2	3.0	1.5					5–10
September 19	60	24.2	—	—	100	54.4	7.5	3.9	5–10
September 20	50	20.1	4.0	2.0	50	27.2	—	—	15
	30	12.0	6.0	3.0	70	38.1			
	40	16.1			60	32.6			
					70	38.1			
September 22	60	24.2	4.0	2.0	70	38.1	13.0	6.8	5–10
					90	49.0			
Average	48.3	19.4	4.5	2.27	75	40.9	8.1	4.2	

has been used. Even with this value the observed-to-calculated ratio of Malabar at San Diego is considerably less than that of Cavite, notwithstanding its greater distance. This may be due to the mountainous surroundings.

Table 2 shows the field strength in microvolts per meter for 1 ohm on the voltage divider of the telephone comparator at the various frequencies observed, with the amplifier adjusted so that 3.2 μv in the coil B gave 50 on the telephone comparator.

On account of an accident to the calibrating apparatus and delays in getting replacements, the first part of the work had to be confined to comparisons of Cavite (NPO) and Malabar (PKX) with the stronger stations, Pearl Harbor (NPM) and Tuckerton (WGG). The Cavite and Malabar average readings were later reduced to microvolts per meter, assuming that the average strengths of Pearl Harbor

TABLE 5.—AVERAGES OF FIELD INTENSITY

	CAVITE (NPO) $E \frac{\mu v}{m}$	MALABAR (PKX) $E \frac{\mu v}{m}$
From direct measurements	2.27	4.22
From comparison with NPM	1.93	3.55
From comparison with WGG	1.93	4.26
Observed averages	2.04	4.02
Calculated from Eq. (1)	0.69	1.83

and Tuckerton were the same as their averages during the second period when the calibrations were being made.

Table 3 gives the comparator readings and the ratios of the various stations for the first period of the observations, while Table 4 shows the results during the second period when the field intensities were measured directly.

The observations contained in the tables were all taken between two and four o'clock in the afternoon, Pacific time. A few observations taken in the morning when the signal path was partly in daylight and partly in darkness, indicated a somewhat greater strength than the afternoon observations; while observations taken by the station operators at the time of darkness along the whole signal path, were reported to be many times stronger than the daylight observations, approaching at times the strength of Pearl Harbor (NPM).

The final values of the field strengths of Cavite and Malabar as derived from comparison with the signals of Tuckerton and Pearl Harbor, and by direct measurement, are shown in Table 5. Below the average observed values are given the values calculated from the Austin-Cohen formula,

$$(1) \qquad E = \frac{377\,I\,h}{\lambda\,d}\sqrt{\frac{\theta}{\sin\theta}}\,e^{-u}$$

where $u = 0.0015d/\sqrt{\lambda}$ and θ is the angle between the stations from the center of the earth.

The observed value of field intensity in the case of Cavite in Table 5 is seen to be approximately three times that calculated from Eq. (1), while the observed strength of Malabar is about twice that calculated from Eq. (1). These ratios of observed to calculated values are much less than those given in M. Guierre's paper.[1]

ZOOLOGY.—*On the alimentary tracts of squirrels with diverse food habits.* A. BRAZIER HOWELL, Biological Survey.

The majority, at least, of the squirrels of the United States may be said fairly to be omnivorous in food habits. At one extreme, however, there are the chipmunks (*Eutamias*) and some tree squirrels which undoubtedly feed as largely as possible upon concentrated fare such as nuts and seeds and occasionally meat. At the other extreme are the gramnivorous prairie dog, marmot, and certain western ground squirrels of the genus *Citellus*.

The difference between these food habit extremes is large, and we would confidently expect some corresponding variation between the internal economy of the two groups discussed. The amount of this difference depends chiefly upon the length of time that present habits have obtained within the species considered, the plasticity of the animal to intestinal variation, and doubtless to unknown complications of one sort or another which it is impossible for the investigator to take into account.

Typical of the group which feeds on concentrated rations is the eastern gray squirrel. It evinces a marked preference for seeds of a nut-like character, and similar items. A variety of provender such as buds, bark, and a small amount of herbage is also consumed, but I am under the impression that such fare is indulged in only when a

supply of more concentrated food is unavailable. This squirrel ranges over a country especially rich in nut-bearing trees, where it encounters comparatively little ecologic competition, as far as we can tell. Too, when its favorite foods show indications of failure it is in the habit of migrating to districts which, from its standpoint, are more favorable. It may therefore be assumed that not very often is this squirrel forced by hunger into eating any great amount of bulky fodder.

Typical of the other extreme is the Belding ground squirrel, selected from among other species with similar habits because specimens chanced to be available. This species undoubtedly has omnivorous proclivities, for I have watched it eating out the soft parts of cicadas (*Okariagana*), and the bodies of small mammals discarded from the skinning table. But it has suffered severe ecologic competition within such associations as appear to us most congenial to such a creature. Over the portion of its range with which I am familiar, every association is occupied by one, or usually more, species of chipmunk, while as many as five forms of other sciuromorphs, partially or entirely terrestrial in habits, may be found dwelling within the same general area. Although prolific, the species is not active, and it appears to us to have been forced by competition into laying its paths in the less crowded places. The more agile chipmunks, which usually fairly swarm about it, hoard stores of food, a thing which the squirrels do not do, and doubtless secure by far the greater part of the local seed crop, almost all obtained by *Citellus* being still in an immature condition. So these little fellows congregate in and about the high mountain meadows where they may feed upon the lush herbage with but few to dispute their menu. I have watched them grazing along through the damp swales, cropping the grass like pygmy cattle, and when one enters a patch of such growth their small forms often scurry away by the score.

These squirrels both aestivate and hibernate, so a great supply of fat must be accumulated. As the food is comparatively low in nutritive value a vast amount must be consumed, and digestion must be rapid. They will stuff themselves until their swollen bellies fairly drag upon the ground, and always the contents of their stomachs and most of the intestinal tract is bright green, a condition which I have not encountered in any tree squirrel, nor among chipmunks unless the latter had been feeding upon green berries.

In examining and comparing the alimentary tracts of these two

mammals it must be born in mind that the gray squirrel was fully a quarter, or possibly a third, larger than the Belding squirrel dissected.

The tree squirrel examined was a spirit specimen, presumably adult, of *Sciurus carolinensis carolinensis* from Washington, D. C. The ground squirrel was subadult—probably a yearling—*Citellus beldingi* from Mammoth, Mono County, California, at an altitude of 9000 feet. In both animals the stomach was well distended.

It was noted that the oesophagus of the *Sciurus* was very small for an animal of such size, its capacity being but little more than half that of the *Citellus*.

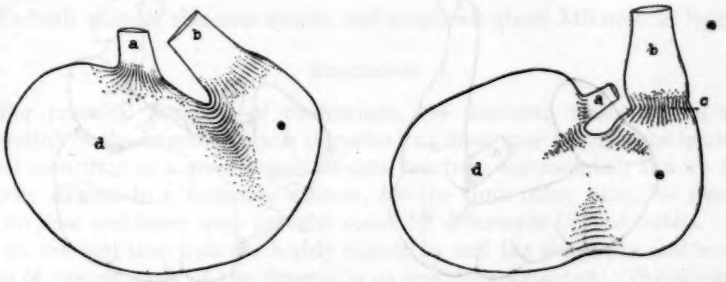


Fig. 1.—Stomachs of *Sciurus carolinensis carolinensis* (left) and *Citellus beldingi* (right): *a* oesophagus; *b* duodenum; *c* pyloric valve; *d* cardiac end; *e* pyloric end. (Both drawn to same scale).

STOMACH

The stomachs of both specimens measured about the same in greatest diameter—namely 50 to 55 mm.—and in breadth they were also somewhat similar; but the stomach of the *Sciurus* was the more capacious due to the fact that the pyloric portion was the more constricted in *Citellus*. In neither are there marked mucous or glandular areas upon the ental surface.

The stomach of *Sciurus*, distended with contents of meal-like consistency and light color, is a simple sack. The cardiac and pyloric tubes are close together—though not in contact—as seems to be the rule in rodents, and there is no external evidence of a pyloric valve. It is as thin-walled and devoid of muscular power as seems possible.

The stomach of the *Citellus* was filled with green vegetable matter markedly fibrous in texture. It was found to be considerably more specialized in this animal, with cardiac and pyloric ends more differentiated, the former being considerably larger than the latter. The two tubes were inclined at a different angle, and there was an external constriction to indicate the position of the pyloric valve. The cranial portion of the cardiac end, and the

entire pyloric division, were much more muscular than in *Sciurus*, with some internal striations.

SMALL INTESTINE

In the *Sciurus* this tract had a length of 1470 mm., with a collapsed width of 7 mm. It was simple, unconvoluted, thin and membrane-like, and uniform for its entire length.

The *Citellus* had a definite duodenal division, 145 mm. long and 8 mm. wide, unconvoluted and markedly reddish in color, in contrast to the grayish

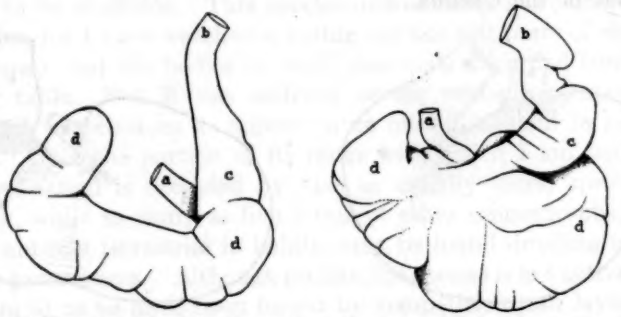


Fig. 2.—Caecal regions of *Sciurus carolinensis carolinensis* (left) and *Citellus beldingi* (right): *a* small intestine; *b* rectal tract; *c* colic portion; *d* caecum. (Both drawn to same scale).

green shade of the remainder of the small intestine, or Meckel's tract.[1] The latter was irregularly convoluted, with a width of 11 or 12 mm. The total length of the small intestine was about 825 mm.

CAECUM

The caecum of the *Sciurus* was shaped like the cross-section of a channel-bar and was relatively simple and vermiform, being but slightly convoluted. In length it measured about 75 mm.

In *Citellus* the caecum was excessively irregular in shape, more spherical and much convoluted. Its longest dimension was about 70 mm., and it was almost as broad. The most capacious part was posterior to the junction with the small intestine. This was not the colic portion, but constituted a posterior extension of the true caecum. There was also a definite protrusion of the caecal wall medially, which may or may not be a step towards, or doubtfully away from, a double caecum.

[1] See MITCHELL, P. C., *On the intestinal tract of mammals*. Trans. Zool. Soc. London 17: 438–536. 1905.

COLIC PORTION

The postcaecal inflation in *Sciurus* consisted merely of a gradual narrowing from the full diameter of the caecum until at 30 mm. from the end of the small intestine the hind gut was uniform in size and character with the remainder of the rectal tract.

In *Citellus* the caecum, posterior to the small intestine, did not narrow gradually. The departure of the hind gut from the caecum was marked by a valve-like constriction, and the colic portion, 25 mm. in length, was convoluted with a suggestion of two loops.

RECTAL TRACT

In both animals this was simple, and measured about 340 mm. in length.

DISCUSSION

For practical purposes of comparison, the unknown quantities in the evolution of the intestinal tract, important as these may be, must be ignored until such time as a great supply of data has been accumulated, and we can merely assume in a tentative manner, for the time being, that the results as we now find them were brought about by differences in food habits.

We are told that nuts are highly digestible, and the simplicity and weakness of the stomach of the *Sciurus* is as might be expected. The citelline stomach, slightly more capacious from a relative standpoint, is more muscular for the handling of tougher, more fibrous food. The easily assimilated food of *Sciurus* is reduced in the large stomach to a condition necessitating but relatively little action by the small intestine and the caecum, both of which are comparatively simple. It is to be noted that the length of the small intestine is actually almost twice as long in *Sciurus* as in *Citellus*, and therefore the additional length may, and probably does, compensate in part for its simplicity. The significance of this discrepancy in length is not clearly understood. It is at variance with what might be expected, after an examination of some of the other rodents which I have dissected, and I venture no opinion as to its real import.

The stomach of *Citellus*, although more muscular, is not of sufficient size to hold for long the great amount of herbage which the animal habitually consumes. The contents, therefore, are soon passed on to the small intestine, more specialized and more efficient for this work than in *Sciurus*. The process is completed in the highly complex caecum, so much better fitted as an engine for the final reduction of coarse fare than is the same part of the tree squirrel.

CONCLUSION

From the foregoing data it is tentatively concluded that in comparing the intestinal tracts of a nut-eating and a grass-eating squirrel, size of the

stomach is not of great import. Muscularity is important in reducing fibrous substances, but a stomach may compensate for lack of great size in handling quantity by passing the contents quickly on to the small intestine and thence to the caecum, both of which must then be of larger diameter and more specialized than is necessary in the case of the animal which feeds chiefly upon nuts.

ZOOLOGY.—*Description of a new scincid lizard and a new burrowing frog from China.* LEONHARD STEJNEGER, U. S. National Museum.

The National Museum has recently received from the Museum of Comparative Zoology, in exchange, two skinks from the province of Yunnan, which appear to represent an undescribed form of the genus *Leiolopisma*, nearly related to the species occurring in eastern and central China, generally known as *L. laterale* or *L. laterale reevesii*. A skink, evidently belonging to the same group as the above, was described in 1879 by Dr. John Anderson[1] from a single specimen collected at Momien, extreme western Yunnan, under the name *Mocoa exigua*. It has not been recognized since, and Boulenger in his Catalog[2] refers to it doubtfully as a synonym of *L. laterale*. Anderson's description is not explicit enough to settle the question, but the coloration as described seems to be sufficiently different from that of *L. laterale* to permit them being considered synonymous, inasmuch as *M. exigua* is said to have "a dark brown band from the snout along the back to the tail, on which it disappears near the root," while in *L. laterale* and its supposed subspecies the back is pale brown or olive with small scattered dusky spots or lines.

Leiolopisma barbouri, sp. nov.

Like *L. laterale*, but legs much smaller; preanals enlarged; four supraoculars; ear-opening about as large as eye-opening; prefrontals separated from anterior supraocular by frontal; forelegs reach corner of mouth; hind legs less than one half the distance between axilla and groin; 26–28 scale rows.

Type locality.—Yunnan-fu, province of Yunnan, China.

Type.—Mus. Comp. Zoöl., no. 7261; J. Graham, collector.

The paratypes in the National Museum (Nos. 68723–4) are essentially like the type, though, because of their less perfect preservation, the measurements are less reliable. All three specimens are rather pale with a narrow dark brown dorso-lateral line from the rostral through eye to the tip of the tail, bordered above by a still narrower whitish line, these lines being located on the fourth scale row on each side from the middle of the back. Pale area

[1] *Zoological results of the two expeditions to Western Yunnan*, p. 797.

[2] Cat. Liz. Brit. Mus. 3: 264. 1887.

of back between the dorso-lateral lines with numerous small dark brown spots which, because they occupy the outer angle of the scale, form interrupted lines down the back. Sides of body and legs more irregularly spotted. Underside whitish with faint grayish lines due to minute dots at the angles of the scales.

The type has 28 scale rows around the middle of the body, the paratypes 26 scale rows.

MEASUREMENTS (IN MILLIMETERS)

	M. C. Z. 7261	U. S. N. M. 68723	U. S. N. M. 68724
Tip of snout to tip of tail	124		
Tip of snout to vent	48	41	38
Tip of snout to ear	7	7	7
Tip of snout to foreleg	12.5	12	14
Axilla to groin	31	25.5	23
Foreleg	8	8	7.5
Hind leg	11	12	11.5

The new species is named in honor of Dr. Thomas Barbour.

In a collection of amphibians and reptiles belonging to the Zoological Museum of the University of Michigan and kindly submitted to me for study, I find a burrowing frog, collected at Nanking, which I believe represents an undescribed species. With the permission of Dr. Alex. Ruthven, I propose to name it:

Kaloula wolterstorffi, sp. nov.

Toes slightly webbed at the base; digits not dilated at tips; upper surface and sides slightly tuberculated; interorbital space nearly twice as wide as upper eyelid; both metatarsal tubercles very large, very close together, inner one nearly twice as long as first toe; subarticular tubercles on toes very weak.

Type locality.—Nanking, province of Kiangsu, China.

Type.—Zool. Mus. Univ. Michigan, No. 60310; N. A. Wood, collector.

This species has a certain similarity to *K. verrucosa* from Yunnan, but differs from it in many important characters as shown by a comparison with two topotypes which the National Museum has obtained from Dr. Thomas Barbour. Thus, for instance, the tips of the fingers which in *K. verrucosa* are broadly truncated, in the new species are tapering; third finger is also relatively longer; web at the base of the toes not much more than a rudiment The inner metatarsal tubercle is enormous, nearly twice as long as the diminutive first toe; the outer one is also very large, the two being nearly confluent at base. The subarticular tubercles are weaker than in *K. verrucosa*, and so are the tubercles on the back, which are smooth and but slightly prominent. The head is also very different. In *K. wolterstorffi* the interorbital width is much greater, being nearly twice as wide as the eyelid, and the snout more pointed and longer, the distance from tip of snout to eye being greater than the diameter of the eye.

Measurements (in millimeters).—Tip of snout to vent, 35; tip of snout to eye, 4.5; diameter of eye, 3.5; width of head, 12; interorbital space, 4.5;

upper eyelid, 2.5; foreleg, 20; hind leg from vent, 38; tibia, 11; inner metatarsal tubercle, 3; first toe from metatarsal tubercle, 1.5.

Quite probably the species here described is the same which Dr. W. Wolterstorff has recorded[3] from Tsingtao, Shantung, under the name *Callula verrucosa*. The deviations noted by him from Boulenger's description of that species tally very well with the Nanking specimen. Such an identification would also make for a more consistent geographical distribution of the two species.

In any event, Dr. Wolterstorff has done so much for the elucidation of the amphibians of eastern China, that the dedication of this new species is well merited.

ENTOMOLOGY.—*New American termites, including a new subgenus.* THOMAS E. SNYDER, Bureau of Entomology, U. S. Department of Agriculture.

Dr. W. M. Mann, of the Bureau of Entomology, visited Guatemala, Honduras, Costa Rica, and Colombia in the winter and spring of 1924, and collected some extremely interesting termites. It is not necessary to state that Dr. Mann is a most successful collector, and has added much to our knowledge of American termites. In addition to collecting the conspicuous tree-nesting species, Dr. Mann painstakingly chopped into hard, solid wood and, in consequence, discovered some remarkable new species in the family Kalotermitidae, including a new subgenus.

From the standpoint of biology and habitat, certain species in the family Kalotermitidae, especially in the subgenera *Cryptotermes* Banks, *Glyptotermes* Froggatt, *Lobitermes* Holmgren, et al., occupy the same rôle among termites (Isoptera) as do species of Bostrichidae (l. s.) among beetles (Coleoptera); they represent the "powder-post" termites, as the latter represent the "powder-post" beetles. Many species in this group are essentially house termites and are of great, or at least of potentially great, economic importance.

Twenty species of termites, of which six are new, were found; this collecting, of course, was incidental to other work.

The new species are: (Family Kalotermitidae) *Kalotermes contracticornis* Snyder, *Kalotermes* (*Calcaritermes*) *imminens* Snyder, *Kalotermes* (*Calcaritermes*) *recessifrons* Snyder, *Kalotermes* (*Glyptotermes*)

[3] Abh. Mus. Magdeburg 1: 145, *pl. 1, f. 1–2.* 1906.

suturis Snyder, *Kalotermes* (*Glyptotermes*) *planus* Snyder; (Family Termitidae) *Armitermes* (*Rhynchotermes*) *major* Snyder.

To the descriptions of these new species there is appended a list of the previously known species of Dr. Mann's collection with a record of the localities and dates of collection, and of the castes obtained.

Kalotermes contracticornis, new species

Soldier.—Head yellow-brown, darker anteriorly, not twice as long as broad, broader posteriorly than anteriorly, sides slightly concave in middle, epicranial suture distinct, front sloping and slightly depressed at origin, head with scattered but not numerous long hairs. Gula narrow in middle; half width at front. Eye spot hyaline, large, reniform. Mandibles black, base reddish, incurved and sharp pointed at apex, broad at base; left mandible with sharp pointed tooth near apex, a broad molar in middle, with apical tooth sharp, and another (molar) near base; right mandible with a sharp pointed tooth in middle and molar near base (Fig. 1).

Antenna yellow, with 13 or 14 segments; segments wedge-shaped, become longer and broader towards apex, not as long as width of head, with long hairs; third segment (if 14 segments) not modified, longer than fourth but shorter than second segment; fifth equal to fourth; last segment short and narrow, wedge-shaped; (if 13 segments) third segment very small, ring-like, shorter and narrower than second or fourth segments; fourth shorter than second, slightly longer and broader than fifth segment.

Pronotum dirty white, tinged with yellow, margins darker (yellow-brown), anterior margin broadly and roundly emarginate, posteriorly slightly emarginate, anterior corners high, sides roundly slope to posterior margin, with scattered long hairs.

Legs tinged light yellowish, femora swollen, but not greatly; tibia with three spines at apex.

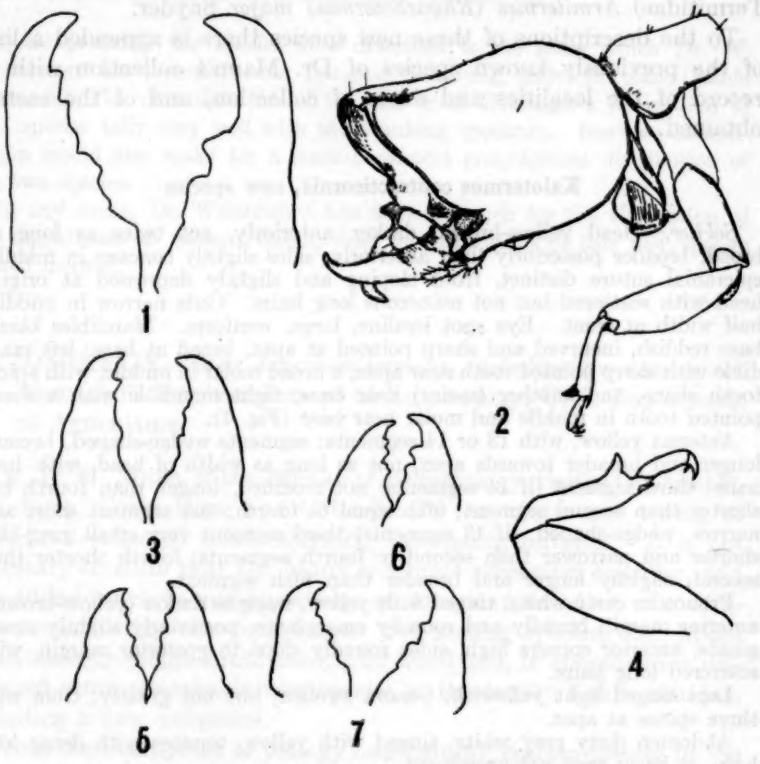
Abdomen dirty grey white, tinged with yellow, tergites with dense long hairs at base; cerci not prominent.

Measurements.—Entire soldier 7.5–8 mm. long; head with mandibles 4–4.3 mm. long; head without mandibles (to anterior) 2.9–3 mm. long; left mandible 1.6 mm. long; pronotum 0.8–0.9 mm. long; hind tibia 1.2 mm. long; head (anteriorly) 1.6–1.7 mm. wide, (posteriorly) 1.7–1.9 mm. wide; pronotum 1.6 mm. wide.

Type locality.—Navarro, Costa Rica.

Described from a series of soldiers collected with nymphs at the type locality in March, 1924, by W. M. Mann. *Type, soldier:* Cat. no. 27733, U. S. N. M.

Kalotermes contracticornis Snyder may be the same species that N. Banks determined as *K. posticus* Hagen (from Jamaica); *posticus* was described by Hagen from the deälated adult alone; *contracticornis* is smaller than *simplicicornis* Banks, of Texas (later, also Arizona), and has less dense pubescence on the head. The marginal teeth of the mandibles are different, and the third segment of the antenna is not as much modified or relatively as large.



Views of head, pronotum, mandibles and forelegs of new species of Kalotermitidae

Fig. 1. *Kalotermes* (*Kalotermes*) *contracticornis* Snyder. Soldier; dorsal view of mandibles to show marginal teeth. Fig. 2. *Kalotermes* (*Calcaritermes*) *imminens* Snyder. Soldier; three quarters view of head, pronotum and foreleg to show overhanging, dorsal, anterior margin of head, scooped out front, and dorsal spur at apex of tibia. Fig. 3. *Kalotermes* (*Calcaritermes*) *imminens* Snyder. Soldier; dorsal view of mandibles to show marginal teeth. Fig. 4. *Kalotermes* (*Calcaritermes*) *imminens* Snyder. Soldier; view of chitinized spur on apex of tibia of foreleg. Fig. 5. *Kalotermes* (*Calcaritermes*) *recessifrons* Snyder. Soldier; dorsal view of mandibles to show marginal teeth. Fig. 6. *Kalotermes* (*Glyptotermes*) *planus* Snyder. Soldier; dorsal view of mandibles to show marginal teeth. Fig. 7. *Kalotermes* (*Glyptotermes*) *suturis* Snyder. Soldier; dorsal view of mandibles to show marginal teeth. (Fig. 2 drawn by Miss E. T. Armstrong; all other drawings made by the writer using camera lucida; all camera lucida drawings on the same scale).

Kalotermes Hagen, subgenus **Calcaritermes**, new subgenus

Soldier.—Head dark colored, fairly elongate, semicylindrical, thick, concave at middle in profile, dorsal anterior margin cleft or lobed medianly. Front of head not vertical but with oblique slope seen from the front, sometimes head with dorsal rim overhanging or projecting, more or less concave or scooped out between upper rim and postclypeus. Mandibles usually short, broad, with marginal teeth. Antenna usually with 11 segments. Forelegs with two spines at apex of tibiae and also a chitinized, elongate, thick (at base), pointed upturned, dorsal spur, femora swollen; cerci present.

Winged adult.—The winged form is similar to those of the subgenera *Glyptotermes* Froggatt and *Lobitermes* Holmgren; the median vein is close to and parallel to the subcosta.

Genotype.—*Kalotermes* (*Calcaritermes*) *imminens* Snyder from Cincinnati, Colombia; *Kalotermes* (*Calcaritermes*) *recessifrons* Snyder, from the same locality, is also included in this new subgenus, as are *Kalotermes* (*Lobitermes*) *nigriceps* Emerson, of British Guiana, *Kalotermes* (*Glyptotermes*) *emarginicollis* Snyder, *Kalotermes* (*Cryptotermes*) *bregicollis* Banks, of Panama, and *Kalotermes* (*Glyptotermes*) *corniceps* Snyder, of Porto Rica.

Kalotermes (*Calcaritermes*) **imminens**, new species

Deälated, female adult.—Head dark castaneous-brown, with reddish tinge, lighter below eyes, shining, longer than broad, slopes anteriorly at epicranial suture, with scattered, fairly elongate hairs. Eye black, markedly not round, projecting, separated from lateral margin by a distance less than the long diameter of an eye. Ocellus hyaline, white, suboval, projecting, separated from eye by a distance less than the diameter of an ocellus, set obliquely to eye.

Antenna light yellow-brown, broken (8 segments[1]), segments bead-like, become markedly longer and broader beyond fourth segment, with long hairs; third segment subclavate, subequal to second but longer than fourth segment.

Pronotum same color as head, anterior margin broadly and roundly emarginate, posterior margin nearly straight, anterior corners high, sides roundly slope to posterior margin, with scattered fairly long hairs.

Legs yellow with tinge of brown, elongate, slender; pulvillus present; femora swollen, tibiae with 3 elongate, chitinized spines at apex, on foreleg 1 spine longer than others, with long hairs.

Abdomen with tergites same color as pronotum, with long hairs at base of each tergite, cerci present.

Measurements.—Entire female, deälated adult 6.3 mm. long; head (to tip of labrum) 1.5 mm. long; pronotum 0.7 mm. long; eye (long diameter) 0.3 mm.; hind tibia 1.3 mm. long; head (at eyes) 1.35 mm. wide; pronotum: 1.1 mm. wide.

Soldier (Fig. 2).—Head castaneous-brown, darker anteriorly (piceous), fairly elongate, semicylindrical, thick (high), concave at middle in profile, head longer dorsally than ventrally, with an overhanging, projecting upper rim, which is cleft or lobed medianly, but the lobes touch (no opening between except at anterior margin), anterior margin of rim roughened. Head with scattered long hairs. Front of head not vertical but with oblique slope

[1] Nymph of sexual form with 13 segments to antenna.

ventrally and towards posterior margin; seen from the front, deeply scooped out, concave like a socket between upper rim and post clypeus. Eye spot dark, not distinct, in depression with antennal socket.

Mandibles piceous, short, broad, with marginal teeth as figured (Fig. 3).

Antenna white, with yellowish tinge, short, with 11 or 12 segments; segments become broader and longer towards apex, with long hairs; third segment (if 11 segments) narrow, short, subclavate, shorter and narrower than second or fourth segments; fourth shorter than second; remaining segments wedge-shaped; last segment narrower, suboval; (if 12 segments) third segment ring-like, very small; fourth much shorter than second or fifth segments.

Pronotum same color as head, not quite as broad as head, anterior margin broadly but angularly emarginate, nearly straight, the posterior margin more roundly but broadly emarginate; sides gradually slope to posterior margin; with scattered long hairs.

Legs white, tinged with yellow, femora swollen, fore tibiae with 2 spines at apex and also a chitinized, elongate, thick, (at base) upturned, pointed dorsal spur, with long and short hairs. (Fig. 4.)

Abdomen grey white, tinged with yellow, with long hairs; cerci present, fairly elongate.

Measurements.—Entire soldier 5.7–6.2 mm. long; head with mandibles 2.1–2.25 mm. long; head to anterior without mandibles (dorsally) 1.7–1.85 mm. long; head to anterior without mandibles (ventrally): 1.55–1.6 mm. long; left mandible 1 mm. long; pronotum 0.8–0.85 mm. long; hind tibia 0.7–0.8 mm. long; head anteriorly 1.4–1.45 mm. high; head posteriorly 1.25–1.3 mm. high; head 1.4–1.5 mm. wide; pronotum 1.4–1.45 mm. wide.

Type locality.—Cincinnati, Colombia.

Described from a series of soldiers collected with nymphs and a deälated adult at the type locality, in February, 1924, by Dr. W. M. Mann. *Type, soldier:* Cat. no. 27734, U. S. N. M.; morphotype, deälated female, adult.

Kalotermes (*C.*) *imminens* Snyder differs from all other known species in nearly related subgenera, and, in view of the overhanging dorsal rim of the head and dorsal spur on the tibia of the forelegs, it was deemed advisable to erect a new subgenus for this species. The specific name refers to the overhanging rim of the head, the subgeneric name to the tibial spur, which does not occur in species of other subgenera of *Kalotermes*.

Kalotermes (*Calcaritermes*) **recessifrons,** new species

Winged adult.—Head dark castaneous-brown, with reddish tinge, lighter below the eyes, shining, longer than broad, sides parallel, rounded posteriorly, with scattered long hairs. Eye black, not round, projecting, separated from lateral margin of head by a distance less than the long diameter of an eye; ocellus hyaline, small, projecting, suboval, nearly touching eye.

Antennae brown, with 13 segments, segments becoming longer and broader towards apex, with long hairs; third segment subclavate, longer than fourth but shorter than second segment; fifth longer than fourth; segments become wedge-shaped towards apex; last segment elongate and subelliptical.

Pronotum same color as head, anterior margin broadly, angularly emarginate, posterior margin nearly straight, sides gradually and roundly slope to posterior margin, not much narrowed posteriorly, with scattered long hairs.

Wings dusky brown, costal veins darker, membrane coarsely punctate; fore wing with median vein close to and parallel to subcostal vein, cubitus in about middle of wing, branches to apex of wing, with sub-branches to lower margin.

Legs light yellow-brown, femora darker dorsally, with 3 elongate spines at apex of tibiae, pulvillus present, pubescent.

Abdomen dark castaneous-brown, with long hairs, cerci present, but not prominent.

Measurements.—Entire winged adult 8–8.25 mm. long; entire deälated adult 4.6–5.3 mm. long; head (to tip labrum) 1.2 mm. long; pronotum 0.7 mm. long; hind tibia 0.9 mm. long; fore wing 6 mm. long; eye (long diameter) 0.275 mm.; head (at eyes) 1 mm. wide; pronotum 0.95 mm. wide; fore wing 1.65 mm. wide.

Soldier.—Head castaneous-brown, darker anteriorly (piceous), fairly elongate, semicylindrical, thick, concave in the middle in profile, head longer ventrally than dorsally, front of head not vertical, sloped anteriorly, ventrally, seen from the front more or less shallowly concave, margin of frontal area not strongly developed, with but only slight outlines of a rim, anterior margin slightly roughened, head lobed medianly at anterior margin(a broad V-shaped, shallow, lobe), head with few, scattered, long and short hairs. Eye spot hyaline, suboval, prominent, separated from antennal socket by a distance greater than its long diameter, long diameter of eye spot parallel to rim of antennal socket. Gula broadest at middle.

Labrum yellow, broader than long, tongue-shaped, with long hairs.

Mandibles piceous, short, broad, with marginal teeth as figured (Fig. 5).

Antenna white, tinged with yellow, short, with 11 segments, the segments become broader and longer towards apex, with long hairs; third segment short, ring-like, shorter and narrower than second or fourth segments; fourth ring-like, short, shorter than second or fifth segments and only slightly longer than third; last segment elongate, narrow, subelliptical.

Pronotum same color as head, not as broad as head, anterior and posterior margins broadly, round-emarginate, anterior corners high, sides nearly straight, with scattered long hairs.

Presternal process dark, (castaneous).

Legs white, tinged with yellow; femora swollen, fore tibiae with 2 spines at apex and also a chitinized, elongate, thick (at base), upturned, pointed dorsal spur, with long and short hairs.

Abdomen gray-white, tinged with yellow, with long hairs; cerci present.

Measurements.—Entire soldier 4.6 mm. long; head with mandibles 2 mm. long; head to anterior without mandibles (dorsally) 1.3 mm. long; head to anterior without mandibles (ventrally) 1.7 mm. long; left mandible 0.7 mm long; pronotum 0.7 mm. long; hind tibia 0.6 mm. long; head 0.9 mm. high; head anteriorly 1.2 mm. wide; head posteriorly 1.3 mm. wide; pronotum 1.25 mm. wide.

Type locality.—Cincinnati, Colombia.

Described from a single soldier, collected with a series of winged adults, at the type locality by W. M. Mann in February, 1924. *Type, soldier:* Cat. no. 27735, U. S. N. M.; morphotype, winged adult.

Kalotermes Hagen, subgenus *Glyptotermes* Froggatt

Winged adult.—The wing venation is very characteristic, the median vein runs parallel and close to the subcostal vein and there are no cross branches; the antennae have 13 segments.

Soldier.—The head is more or less elongate, the front is steeply oblique and often somewhat scooped out or concave and lobed; the antennae usually have 10 to 12 segments; the mandibles are relatively short and broad.

The subgenus *Lobitermes* Holmgren is closely related to *Glyptotermes;* the winged adult is as in *Glyptotermes.* The soldier of species of *Lobitermes* has the head deeply lobed, relatively short, thickly cylindrical, and with the front nearly vertical. The head is shorter and darker colored (blacker) than in *Glyptotermes,* and the antennae have more segments (11 to 14). The mandibles are short, and are hardly visible from above.

Kalotermes (*Glyptotermes*) **planus,** new species

Winged, female adult.—Head deep castaneous-brown, with reddish tinge, lighter below eyes, longer than broad, with scattered long hairs. Eyes black, not round, slightly projecting, separated from lateral margin of head by a distance less than long diameter of eye. Ocelli hyaline, suboval, projecting, close and at oblique angle to eyes.

Antennae yellow-brown, 11 segments, segments bead-like, becoming very much longer and broader towards apex, with long hairs; third segment subclavate, short and narrow, shorter than second or fourth segments; fourth segment shorter than second segment; fifth longer and broader than fourth segment; last segment slender, elongate, subelliptical, with truncate apex.

Pronotum same color as head, anterior margin broadly angularly emarginate, posterior margin nearly straight, anterior corners high, sides roundly slope to posterior, with scattered long hairs.

Wings dusky, smoky, costal area darker (brown), tissue coarsely punctate; median vein close to and parallel to subcosta; cubitus nearly in center of wing, slightly nearer to median vein than to lower margin of wing, branching to apex of wing.

Legs yellow, elongate, slender, pulvillus present, pubescent.

Abdomen with tergites the same color as pronotum, with long hairs; cerci present.

Measurements.—Entire winged adult 6.7 mm. long; entire deälated adult 4.8 mm. long; head (to tip labrum) 1 mm. long; pronotum 0.5 mm. long; fore wing 5.15 mm. long; hind tibia 0.7 mm. long; eye (long diameter) 0.235 mm.; head (at eyes) 0.80 mm. wide; pronotum 0.75 mm. wide; fore wing 1.35 mm. wide.

Soldier.—Head yellow, darker anteriorly (light yellow-brown to light castaneous-brown, with a reddish tinge), paler posteriorly, in profile head in nearly a straight line, not high, front slopes obliquely, anteriorly, with broad rounded median suture, lobes but very little elevated, slightly roughened, with scattered fairly long hairs (a row of longer hairs both anteriorly and posteriorly).

Eye spot not distinct, suboval, close to rim of antennal socket.

Gula narrower in middle.

Mandibles reddish-brown at base, piceous at apex, short and broad, marginal teeth as figured (Fig. 6).

Antennae white, tinged with yellow, 10 segments, segments wedge-shaped, becoming longer and broader towards apex, with long hairs; third segment subclavate, narrower and shorter than second or fourth segments; fourth segment only slightly longer than third but quite a little shorter than second;

fifth longer and broader than fourth segment; last segment short, narrow, wedge-shaped.

Pronotum yellow, darker, light yellow-brown on margins, anterior margin broadly angularly emarginate, posterior margin slightly convex, nearly straight, slight median emargination, anterior corners high, sides narrowed (angularly slope) posteriorly, with scattered long hairs.

Presternal processes light yellow-brown.

Legs light yellow, femora swollen, tibiae with three chitinized apical spines, with long hairs.

Abdomen with tergites gray-white with yellowish tinge, with long hairs, cerci present.

Measurements.—Entire soldier 4.8–4.9 mm. long; head with mandibles 1.7–1.85 mm. long; head to anterior without mandibles (dorsally) 1.1 mm. long; head to anterior without mandibles (ventrally) 1.25 mm. long; left mandible 0.65 mm. long; pronotum 0.45 mm. long; hind tibia 0.5 mm. long; head 0.8 mm. high; head anteriorly 0.8 mm. wide; head posteriorly 0.9 mm. wide; pronotum 0.85–0.9 mm. wide.

Type locality.—Colombiana, Costa Rica.

Described from three soldiers collected with two winged female adults and nymphs at the type locality in April, 1924, by W. M. Mann. *Type, soldier:* Cat. no. 27736, U. S. N. M.; morphotype, winged female adult.

The soldier of *K. (G.) planus* Snyder has a light colored head, with anterior lobes not prominent; winged adult with only 11 segments to antennae and small eyes.

Kalotermes (*Glyptotermes*) **suturis** new species

Winged female adult.—Head light castaneous-brown with a reddish tinge, darker on vertex, lighter below the eyes, not much longer than broad front with an oblique slope anteriorly, with scattered long hairs. Eyes black, not round, projecting, separated from lateral margin of head by a distance less than an eye diameter. Ocelli hyaline, suboval, projecting, almost touching and at an oblique angle to eyes.

Antennae light yellow-brown, (broken 8 segments), segments bead-like, become longer and broader towards apex, with long hairs; third segment subclavate, narrow, slightly longer than fourth but slightly shorter than second segment; fifth longer and broader than fourth segment.

Pronotum slightly darker than head, anterior margin broadly angularly emarginate, posterior margin slightly and shallowly, roundly emarginate, anterior corners high, sides roundly slope posteriorly, with scattered long hairs.

Wings dusky, smoky brown, costal area darker (brown), coarsely punctate; in fore wing, median vein close to and parallel to subcosta, cubitus nearly in center of wing, slightly closer to median vein than to lower margin of wing, branching to apex of wing.

Legs light yellow-brown, elongate, slender, pulvillus present, pubescent.

Abdomen with tergites about same color as pronotum, with long hairs at base; cerci present, not prominent.

Measurements.—Entire winged adult 7.8 mm. long; entire deälated adult 6.3 mm. long; head (to tip labrum) 1.3 mm. long; pronotum 0.6 mm. long; fore wing 6 mm. long; hind tibia 1 mm. long; eye (long diameter) 0.275 mm. head (at eyes) 1.2 mm. wide; pronotum 1 mm. wide; fore wing 1.7 mm. wide.

Soldier.—Head light yellow, darker (yellow-brown) anteriorly, longer than broad, slightly broader posteriorly, sides approximately parallel, slightly

concave anteriorly in profile, front obliquely, angularly sloping anteriorly, broad, rounded suture medianly, margins of lobes rounded, not roughened, lobes slightly elevated, head with scattered long hairs. Eye spot hyaline, elongate long diameter parallel to rim of antennal socket, separated from antennal socket by a distance equal to the long diameter of the eye spot. Gula elongate, narrow at middle. Labrum light yellow, broader than long, tongue-shaped, with long hairs.

Mandibles reddish brown to piceous at apex, short and broad; marginal teeth as figured (Fig. 7).

Antennae light yellow, 10 segments, segments become longer and broader (wedge-shaped) towards apex, with long hairs; third segment short, subclavate, shorter than second but slightly longer than fourth segment; fourth ring-like, only slightly shorter than third segment but much shorter than second; fifth longer than fourth segment; last segment narrower, wedge-shaped.

Pronotum yellow, margins light yellow-brown, broadly shallowly roundly emarginate at anterior margin, posterior margin nearly straight, sides angularly slope posteriorly, anterior corners high, with scattered, long hairs.

Presternal processes light yellow-brown.

Legs white tinged with yellow, femora swollen, tibiae with 3 chitinized elongate spines at apex, with scattered, long hairs.

Abdomen gray-white, tinged with yellow, with long hairs; cerci present.

Measurements.—Entire soldier 5 mm. long; head with mandibles 2.25 mm. long; head to anterior without mandibles (dorsally) 1.35 mm. long; head to anterior without mandibles (ventrally) 1.5 mm. long; left mandible 0.8 mm. long; pronotum 0.55 mm. long; hind tibia 0.7 mm. long; head 0.95 mm. high; head anteriorly 1.05 mm. wide; head posteriorly 1.15 mm. wide; pronotum 1 mm. wide.

Type locality.—La Carpentera, Costa Rica.

Described from a single soldier collected with a winged female adult and nymphs at the type locality in April, 1924, by W. M. Mann. *Type, soldier.*—Cat no. 27737, U. S. N. M.; morphotype, female winged adult.

The soldier of *K.* (*G.*) *suturis* Snyder has a light-colored head, with a rounded suture at the front of the head, the lobes being slightly elevated and rounded.

Armitermes (*Rhynchotermes*) **major,** new species

Soldier.—Head light castaneous-brown, middle of beak or nasus and mandibles darker, reddish-brown (to piceous), head relatively short, pear-shaped (with base of nasus), otherwise round, nasus very elongate, curved downward, becoming gradually attenuated towards apex, where there are short hairs, 1 row short hairs on head anteriorly. Mandibles relatively very short, bent inwards or hook-shaped, inner margin near tips not crenulate, near center of each mandible a long outward curved, sharp, pointed marginal tooth.

Antenna yellow-brown, elongate, slender (with 14 elongate segments), with long hairs; third segment subclavate, longer than first, longer than second or fourth; fourth segment longer than second; fifth segment longer than fourth; segments gradually becoming shorter but broader towards apex; last segment subelliptical.

Pronotum light-brown, darker on margins, saddle-shaped, broader than long, high and roundedly narrow at anterior margin, where emarginate, broadly rounded posteriorly; long hairs on anterior margin.

Legs yellow, with tinge of brown, elongate, with scattered long, but sparse hairs; coxae of fore legs with an elongate point or sharp process, sometimes hook-shaped and curving; two spines at apex of tibia.

Abdomen dirty gray-white, with tinge of yellow (to yellow-brown), with row of long hairs at base of each tergite.

Measurements.—Entire soldier 5.5–6 mm. long; head with nasus 3–3.2 mm. long; head with mandibles 1.8 mm. long; head to anterior 1.2 mm. long; nasus 1.9 mm. long; left mandible 1.2 mm. long; pronotum 0.4 mm. long; hind tibia 1.85–2 mm. long; head (at widest portion) 1.15–1.25 mm. wide; pronotum 0.7 mm. wide.

The soldier of *A.* (*R.*) *major* Snyder is darker colored, larger than *nasutissimus* Silvestri, it has a longer, more aquiline head and nasus, longer mandibles, and long, pointed marginal teeth, the antennae have longer segments, the process on the coxae is longer and more pointed; in comparison with *perarmatus* Snyder, *major* is slightly darker colored and is consistently larger.

Worker.—The head of the worker is light castaneous-brown, with scattered long hairs, with prominent, hyaline, round, raised fontanelle (larger than in *perarmatus*), it is darker colored and larger than the worker of *nasutissimus* or *perarmatus;* antennae with 14 segments; post-clypeus about same color as head, bulging, bilobed.

Measurements.—Entire worker 4.7–5.3 mm. long; head 1.7 mm. long; pronotum 0.45 mm. long; hind tibia 1.7 mm. long; head tibia 1.7 mm. long; head 1.4 mm. wide; pronotum 0.7 mm. wide.

The winged adult is unknown.

Type locality.—Estrella, Costa Rica.

Described from a large series of soldiers and workers collected in April, 1924, at the type locality by Dr. W. M. Mann. *Type, soldier.* Cat. no. 27738, U. S. N. M.

Dr. Mann also found specimens of the termite at Sangrelaya, Honduras, in May, 1924, under the bark of a decayed log. I previously referred these specimens to the species *perarmatus* Snyder, from Panama, but this additional material shows a large series which are of constantly larger size and are hence referred to the species *major* Snyder.

LIST OF DESCRIBED SPECIES

KALOTERMITIDAE

KALOTERMES (KALOTERMES) TUBERCULIFRONS Snyder

GUATEMALA, Antigua (El Potrero, Finca Vic, three soldiers, collected by J. R. Slevin). These soldiers were compared with the type from Mexico; the antennae of the type were broken off at the fourth segment, but the soldiers from Antigua have 13 segments to the antennae; the head is slightly broader anteriorly in the type, whereas in these specimens the head is broader posteriorly, the eye spot is darker and smaller, and the femora more swollen, than in the type.

RHINOTERMITIDAE

LEUCOTERMES TENUIS Hagen

COLOMBIA: Rio Frio, Feb., 1924 (soldiers and workers with *Termitaphis* sp.) Rio Frio, Feb., 1924 (soldiers with *Microcerotermes exiguus* Hagen, queens, soldiers and workers).

PRORHINOTERMES MOLINOI Snyder
COSTA RICA: Zent, March, 1924 (soldiers and workers with soldiers and workers of *Coptotermes niger* Snyder).

COPTOTERMES NIGER Snyder
GUATEMALA: Mixco, May, 1924 (soldiers and workers).
COSTA RICA: Zent, March, 1924 (soldiers and workers with *Prorhinotermes molinoi* Snyder, soldiers and workers).
COLOMBIA: Rio Frio, Feb., 1924 (soldiers and workers).

TERMITIDAE

AMITERMES MEDIUS Banks
COLOMBIA: Rio Frio, Feb., 1924 (soldiers, workers and nymphs). Santa Ana, Feb., 1924 (soldiers, workers and nymphs).

CORNITERMES (*Cornitermes*) ACIGNATHUS Silvestri
COSTA RICA: Colombiana, April, 1924 (soldiers and workers).

NASUTITERMES (*Nasutitermes*) CORNIGERA Motschulsky
GUATEMALA: Mixco, May, 1924 (queen, king, soldiers and workers).
HONDURAS: Sangrelaya, March, 1924 (queen, king, soldiers and workers). Sangrelaya, March, 1924 (queens, kings, soldiers and workers). Malva, May, 1924 (queens, kings, soldiers and workers).
COSTA RICA: Colombiana, March, 1924 (queen, soldiers and workers). El Coyolar, March, 1924 (queen, soldiers and workers). Zent, March, April, 1924 (queen, soldiers and workers). Estrella, April, 1924 (queen soldiers and workers). San Mateo, April, 1924 (queen, king, winged adults, soldiers and workers).

NASUTITERMES (*Nasutitermes*) EPHRATAE Holmgren
HONDURAS: Sangrelaya, May, 1924 (3 queens, winged adults, soldiers and workers in ball nest—outer shell 2″ thick and very hard). Sangrelaya, May, 1924 (queen, soldiers and workers).
COSTA RICA: Colombiana, March, 1924 (queen, soldiers and workers in nest on ground). Colombiana, April, 1924 (winged adults, soldiers and workers).

NASUTITERMES (*Nasutitermes*) ROTUNDATUS Holmgren
COSTA RICA: Colombiana, April, 1924 (soldiers and workers).

NASUTITERMES (*Tenuirostritermes*) TENUIROSTRIS Desneux
GUATEMALA: Antigua, May, 1924 (soldiers and workers). Palin, May, 1924 (soldiers and workers).

ANOPLOTERMES (*Anoplotermes*) SP.
COSTA RICA: El Coyolar, April, 1924 (workers and nymphs).

ANOPLOTERMES (*Speculitermes*) SP.
COLOMBIA: Rio Frio, Feb., 1924 (workers marching from nests in files, cutting leaves and carrying cut pieces).

MICROCEROTERMES ARBOREUS Emerson
HONDURAS: Ceiba, April, 1924 (queens, winged adults, soldiers and workers).

MICROCEROTERMES EXIGUUS Hagen
GUATEMALA: Esquintla, May, 1924 (queen, soldiers and workers).
COLOMBIA: Rio Frio, Feb., 1924 (queen, soldiers and workers). Rio Frio, March, 1924 (queens, soldiers and workers with soldiers of *Leucotermes tenuis* Hagen).